A System for Accurate Collocation of Haptics and Graphics

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I would conservatively estimate that in the last six years I have demonstrated haptic and graphic enabled virtual environments to over a thousand individuals. These individuals range from highly skilled surgeons to first graders. Having witnessed these interactions, I have come to the following conclusion: some people do better with Virtual Reality (VR) than others. Discussions of this variance usually focus on the computer familiarity of the user, which bodes well for the video game player. I would like to suggest the following hypothesis: The major difference in people's VR savvy is their varying ability to adapt to miscues in the virtual environments. If this is true, the following follow:

- The user's performance in a highly accurate virtual environment will not differ significantly from their performance in a real environment.
- There is a significant disparity across users between the correlation of the degradation of skills and degradation of the virtual environment.
- If standards are not developed and maintained, individuals not adept at adapting to miscues will be discriminated against as virtual environments make their way into the mainstream of training and testing.

Many systems have been developed to collocate the apparent graphic position of a virtual scene with a haptic workspace. The use of mirrors for this purpose is particularly popular, as they are inexpensive and have the natural effect of hiding the haptic from the viewer. However, the systems that I have experienced--including the one designed and used at the University of Colorado's Center for Human Simulation--allow for motion of the user's head without appropriately compensating for the implied change in the location and orientation of the virtual camera. The disparity between the true view point and the virtual viewpoint is a direct source of error in the collocation of the haptic and graphic scene.

For mirror systems, two methods come to mind for fixing this disparity: head tracking and fixing the position of the user's head. We have chosen to create a system that does the latter. In our latest system, the user views the virtual environment in much the same way that a person looks through a microscope. This fixes the eye position. There are many other factors that go into making an accurate virtual environment, including:

- calibration of the haptic display device
- calibration of the graphic display device
- graphic refresh rate
- graphic resolution
- proper stereo cues
- proper math

But all of the above are, to a large extent, under the control of the designer.

This presentation introduces a haptic and graphic workstation designed and built with the emphasis on presenting the user with an accurate virtual environment. We expect this system to be a useful display for many of our medical simulators. The more intriguing potential of the system lies in what it may teach us about people using virtual environments.